REMARKS

In response to the Office Action mailed January 15, 2002, Applicants respectfully request reconsideration.

Claims 1-34 have been previously examined. By this Amendment, claims 1, 4, 5, 6, 20, 26, 29 and 30 are amended, claims 3, 9, 28 and 34 are canceled, and claims 35-66 are new. Accordingly, claims 1, 2, 4-8, 10-27, 29-33 and 35-66 are pending in this application, of which claims 1, 10, 26, 35, 43, 47, 52, and 62 are independent claims. The application as presented is believed to be in allowable condition.

Each of the pending claims were rejected as being anticipated by Rosenberg et al. (U.S. Patent No. 6,278,439). However, while Rosenberg and the present invention are both directed, generally, to haptic interfaces and virtual environments, the subject matter that they relate to are very different.

In a virtual environment including haptic feedback, there are numerous and diverse considerations. A first set of related considerations involves the simulation of virtual three-dimensional bodies or objects in a virtual three-dimensional space. These considerations may include the representation of the objects, simulated interaction of the objects, such as collision detection, calculation of appropriate forces resulting from the simulated interaction, etc. These are computational considerations.

A second set of related considerations involves the physical haptic device itself. These considerations may include the various mechanical and electrical devices such as sensors, actuators, and motors, the signals used to drive the device actuators, etc.

The present application is directed largely to concepts related to the first set of considerations while Rosenberg is directed to concepts related to the second set of considerations.

In particular, Rosenberg is directed to a method of modifying a force feedback signal by shaping it with an impulse in order to effect a sensation while saving dynamic range of the actuator. However, the whole of the Rosenberg teaching occurs <u>after</u> a force feedback has been computed by some other simulation or computational framework (e.g., a host application program). While Rosenberg mentions several examples of <u>where</u> such a force feedback may come from (e.g., a video game simulation), Rosenberg provides no detail as to <u>how</u> such a force feedback may be generated. Indeed, Rosenberg is completely silent with respect to

computational considerations involved in a simulated interfacing of virtual objects in a virtual environment. Accordingly, the teachings of Rosenberg relied upon in the rejections set forth in the Office Action have no anticipatory relationship with the subject matter of the present invention as recited in the claims.

In short, nowhere in Rosenberg are any specific methods with respect to simulated interfacing of two bodies or objects, object representation, collision detection, or generation of a force vector from detected collisions ever addressed. In addition, Rosenberg is completely silent with respect to concepts relating to guiding a simulated object in a desired relationship with at least one other simulated object. In particular, concepts related to niceness factors, posture maps, guide zones, snap-fit regions, constraint layers etc., are entirely absent from the Rosenberg reference.

I. Rejections Under 35 U.S.C. §102

The Office Action rejects claims 1-34 under 35 U.S.C. §102(e) as being anticipated by Rosenberg et al. (U.S. Patent No. 6,278,439). Applicants respectfully traverse this rejection.

In ¶3 of the Office Action, the Examiner cites various sections of Rosenberg as anticipating the subject-matter of claims 1, 9-10, 26 and 34. As best as can be understood, the Examiner seems to indicate that the mere mention of a car simulation including "hitting a pothole or getting side swiped by another car" anticipates the collision detection recited in the claims. Rosenberg is simply giving an example of a host application program that may generate a force feedback. However, Rosenberg provides no detail concerning the computational methods used in such a simulation. Accordingly, there is simply no evidence that the car simulation discloses the collision detection as recited in the claims. For example, claim 1 recites "detecting any collision between the first body and the second body, including the position on each body of each collision, the direction of the collision, and force for the collision." Claims 10 and 26 recite similar limitations not disclosed in Rosenberg.

Furthermore, the impulse-shaped force signal has been improperly characterized as a force vector computed from the simulated interaction of virtual objects. The Examiner states, "Rosenberg teaches a vector representing a force and the generation of feel sensation and its representation in simulation. See column 3, lines 17-37." This excerpt describes the impulse-shaped force signal applied to a force feedback.

However, the impulse-shaped force signal is <u>not</u> generated from the simulated collision of objects as recited in the claims. Rather, it's a post-processing method of modifying a force feedback signal to preserve actuator dynamic range. Again, Rosenberg merely mentions that a force feedback may be generated someway, somehow, but provides no detail as to the computational methods of generating such a force feedback signal. As such, Rosenberg does not teach or suggest the methods for providing a force feedback as recited in the claims. For example, claim 1 recites "converting the detected direction, point and force for each collision into at least one force vector on the first body." Claims 10 and 26 recite similar limitations not disclosed in Rosenberg.

Accordingly, Rosenberg simply does not anticipate the claims of the present invention for at least these reasons. However, in order that the claims remain consistent with a corresponding PCT application and to more distinctly point out distinguishing subject matter over the references of record, Applicants have amended the claims.

In particular, claim 1 has been amended to recite that the stored representations of the bodies include an implicit representation and a discrete representation. Rosenberg is completely silent with respect to methods of representing objects, and hence, does not teach or suggest storing selected representations of said first body and of said second body "the representation for one of said bodies being an implicit representation and the representation for the other body being a discrete representation", as recited in claim 1. Therefore, claim 1 patentably distinguishes over Rosenberg and the art of record or otherwise known to Applicant and is in allowable condition.

Claims 3-8 depend from, and further limit, claim 1 and are allowable for at least the same reasons indicated for claim 1. However, claims 3-8 contain additional subject matter that further patentably distinguish over Rosenberg. Applicants believe that certain concepts recited in the dependent claims did not receive proper consideration or were otherwise mischaracterized in the rejections set forth in the Office Action. Accordingly, Applicants respectfully point out certain limitations of these claims that further patentably distinguish over Rosenberg. However, the particular selection of additional subject matter discussed herein is not an indication of the only subject matter Applicant deems patentable in the dependent claims.

In particular, dependent claims 7 and 8 recite further novel concepts related to the simulated interfacing of a first and a second body. Specifically, claims 7 and 8 recite niceness factors and guide zones, respectfully.

Claim 7 recites the method of claim 1 including storing a niceness factor for at least one feature of said first body and utilizing the niceness factor to influence said force vector.

In the Office Action, the Examiner states that "Regarding claims 7 and 32, Rosenberg teaches the source wave of which is of a type "force profile", as a series of pre-defined digital force values that can be stored in a storage device. See column 15, lines 66-67 and column 16, lines 1-7." Rosenberg discloses that the source wave (i.e., the drive signal eventually applied to the actuator of an interface device) may be a "force profile" which is a series of predefined digital force values that can be stored in a storage device. This is to say, Rosenberg provides an alternative form that the force signal (i.e. the waveform) to be provided to the actuator or motor may take.

However, the source wave of Rosenberg is certainly not equivalent to the first body or even a feature of the first body as recited in claim 7. In addition, the "force profile" is simply not a niceness factor in any way. Applicants respectfully direct the Examiner's attention to the final paragraph on page 12 of the present application where a niceness factor is defined as a measurement of the acceptability and desirability of contact between a portion or feature of a body to which it is associated and another body. This is wholly unrelated to the subject matter disclosed in Rosenberg as cited in the Office Action. Indeed, nowhere in the citations provided by the Examiner or anywhere in Rosenberg is the concept of a niceness factor disclosed or suggested. Accordingly, the concept of a niceness factor associated with a feature of a first body as a further influence on the at least one force vector is neither disclosed nor suggested in Rosenberg and further distinguishes the subject-matter of claim 1 over Rosenberg. Claim 7 is allowable for at least this additional reason.

Claim 8 recites the method of claim 1 including defining a guide zone around at least a portion of one of said bodies and providing a force feedback to said interface device to urge the first body toward the second body when the bodies are not in contact but the guide zone of the one body is detected as having the other body therein.

In the Office Action, the Examiner states that "Regarding claims 8 and 33, Rosenberg teaches that the user can use the computer system in conjunction with supplied feedback when

grasping or contacting the object of the interface device. See column 1, lines 49-57." However, Rosenberg simply lists general uses of a haptic interface that are known in the art. The above referenced lines are wholly unrelated to guide zones. Moreover, nowhere in Rosenberg is such a concept provided. In particular, Rosenberg does not disclose or suggest a guide zone around at least one of the bodies, wherein the first body is urged toward the second body when within the guide zone, as recited in claim 8. Therefore, claim 8 further patentably distinguishes the subject matter of claim 1 over Rosenberg. Claim 8 is in allowable condition for at least this additional reason.

Claim 10 recites a method for generating CAD/CAM postures for a tool operating on a body. As discussed above, concepts related to storing postures of a simulated object are entirely absent from Rosenberg. In particular, Rosenberg does not teach or suggest "storing postures of the tool where the tool collides with the body at a working surface of the tool, but does not otherwise collide with the tool as potential CAD/CAM postures", as recited in claim 10. Therefore, claim 10 patentably distinguishes over Rosenberg and is in allowable condition.

Claims 11-25 depend from, and further limit, claim 10 and are allowable for at least the same reasons as indicated for claim 10. However, claims 11-25 contain additional subject matter that further patentably distinguish over Rosenberg. Applicants believe that certain concepts recited in the dependent claims did not receive proper consideration or were otherwise mischaracterized in the rejections set forth in the Office Action. Accordingly, Applicants respectfully point out certain limitations of these claims that patentably distinguish over Rosenberg. However, the particular selection of additional subject matter discussed herein is not an indication of the only subject matter Applicant deems patentable in the dependent claims.

Claim 13 recites the method of claim 10 wherein said representation of the tool includes a niceness factor, the niceness factor being higher for regions of the tool where contact is desired, and decreasing for regions as a function of desired contact in such regions.

As discussed above in connection with claim 7, the concept of niceness factors is entirely absent from Rosenberg. As such, a tool including " a niceness factor, the niceness factor being higher for regions of the tool where contact is desired, and decreasing for regions as a function of desired contact in such regions," as recited in claim 13 further patentably distinguishes the subject-matter of claim 10 over Rosenberg.

Claim 20 recites the method of claim 17 (which ultimately depends from claim 10) including defining a snap-fit region for said tool around each working surface wherein contact with the second body is desired.

Claim 21 recites the method of claim 20 including applying a force to said interface device to urge said tool toward the body when the body and tool are not in contact but the body is in a said snap-fit region of said tool.

In the Office Action, the Examiner states that "Regarding claims 17, 20, and 21, Rosenberg teaches a stiffness condition through force vs. Displacement graph (180) where the applied force is continuous. See Fig. 3a." However, the force vs. Displacement graph 180 is a technique used by Rosenberg to effect certain sensations, such as stiffness, on the user object. Applicants respectfully point out that the user object of Rosenberg is the physical interface device, not a simulated object such as the tool representation recited in claim 10 and associated dependent claims. Indeed, the force vs. Displacement graph simply is not a guide zone or a snap-fit region.

It should be appreciated that a guide zone or snap-fit region, as described on page 18 of the present Application (and elsewhere), provides a region around a simulated object that, when another object penetrates the regions, influences the computed force vector to urge the penetrating object towards the object having the guide zone.

The force vs. displacement graph simply defines a condition or effect on a haptic interface device (i.e., user object 34) it does not define a *snap-fit region around each working surface of a tool* wherein contact with the second body is desired, as recited in claim 20. The specific relationship between the snap-fit region and the *simulated objects* (i.e., the tool and the body) as recited in the claim 20 needs to be considered. Rosenberg simply does not provide specific teaching related to simulating objects, and as such, does not disclose or suggest techniques for guiding such a simulation such as providing a snap-fit region around portions of a tool being simulated.

Furthermore, the snap-fit region of claim 21 recites providing a force to urge a tool towards a body "when the body and tool are not in contact but the body is in said snap-fit region of said tool." This concept is also entirely missing from the Rosenberg disclosure.

As discussed above, guide zones, such as snap-fit regions are nowhere disclosed or suggested by Rosenberg. Accordingly, claims 20 and 21 further patentably distinguish the

subject-matter of claim 10 and all intervening claims over Rosenberg and are allowable for at least these additional regions.

Claim 22 recites the method of claim 10 wherein a part is being machined from the body and material is being removed from the body in layers, including establishing constraints at layer boundaries, and detecting collisions between the tool and a selected operative constraint.

In the Office Action, the Examiner states that "Regarding claim 22, Rosenberg teaches conveying a "feel sensation" as strong impact followed by subdued steady state force level See column 17, lines 37-40." This is wholly unrelated to the subject matter recited in claim 22. Applicants respectfully direct the Examiner to the discussion beginning at the last paragraph on page 14 and to Fig. 1 for an appropriate description.

Applicants respectfully submit that nowhere in Rosenberg is it disclosed or suggested to machine a part from a body by removing layers having constraints at the boundaries. Accordingly, nowhere in Rosenberg is it taught or suggested to detect collisions between the tool and constraints as recited in claim 22. Therefore, claim 22 provides additional patentable subject-matter further distinguishing claim 10 over the Rosenberg reference.

Claim 26 has been amended to recite that the representations for the first and second bodies include an implicit representation and the other include a discrete representation. As discussed above in connection with claim 1, Rosenberg neither discloses nor suggests storing representations of a first and a second body, "the representation for one of said bodies being an implicit representation and the representation for the other body being a discrete representation", as recited in claim 26. Therefore, claim 26 patentably distinguishes over Rosenberg and is in allowable condition.

Claims 27-33 depend from and further limit claim 26 and are allowable for at least the same reasons. Applicants point out that said dependent claims also recite patentable subject matter discussed in the foregoing. In particular, claim 32 recites subject matter including a niceness factor and claim 33 recites subject matter including a guide zone.

IV. New Claims

Various novel concepts conceived and implemented by Applicants have been discussed herein. Each of new claims 35-66 recite subject matter related to such concepts including full-

body simulated interfacing of objects, posture maps, and guide zones. Each of new claims 35-66 further define Applicants' contribution to the art and are believed to be in allowable condition.

Each of the new claims either recites subject matter in independent form that appear elsewhere in the pending dependent claims, or more distinctly point out and define elements found in the previously examined claims. Accordingly, the new claims do not require a new search. Consideration of the new claims in view of the foregoing remarks is respectfully requested.

CONCLUSION

In view of the foregoing amendments and remarks, this application should now be in condition for allowance. A notice to this effect is respectfully requested. If the Examiner believes, after these amendment and remarks, that the application is not in condition for allowance, the Examiner is requested to call the Applicants' attorney at the telephone number listed below.

If this response is not considered timely filed and if a request for an extension of time is otherwise absent, Applicants hereby request any necessary extension of time. If there is a fee occasioned by this response, including an extension fee that is not covered by an enclosed check, please charge any deficiency to Deposit Account No. 23/2825.

Respectfully submitted

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MARKED-UP CLAIMS

1. A method for controlling the simulated interfacing of a first body controlled by a user with a second body, while providing haptic feedback to the user on such interfacing including:

storing selected representations of said first body and of said second body in a processing apparatus, the representation for one of said bodies being an implicit representation and the representation for the other body being a discrete representation;

using a user controlled interface device to control simulated movement of the first body relative to the second body;

detecting any collision between the first body and the second body, including the position on each body of each collision, the direction of the collision, and force for the collision;

converting the detected direction, point and force for each collision into at least one force vector on the first body; and

applying said at least one force vector as a corresponding feedback force vector to said interface device, and thus to the user.

[3. A method as claimed in claim 1 wherein at least one of said representations is an implicit equation representation of the body.]

4. A method as claimed in claim [3] 1 wherein said first body representation is a binary space partition tree representation.

5. A method as claimed in claim [3] 1 wherein force for a collision is represented at least in part by penetration of the body represented by the implicit [equation] representation into the other body.

6. A method as claimed in claim 1 wherein [at least one of] said discrete representation[s] is a point cloud representation of the body.

[9. A method for controlling the simulated interfacing of a first body controlled by a user with a second body not under user control, while providing haptic feedback to the user on such interfacing including:

storing a point cloud representation of at least one of said bodies; and

utilizing said point cloud representation in said simulation.]

20 (Amended) A method as claimed in claim 17 including defining a snap-fit region for said tool around each working surface wherein[, desired contact region thereof] contact with the second body is desired.

26. A system for controlling the simulated interfacing of a first body controlled by a user with a second body, while providing haptic feedback to the user on such interface including:

at least one memory storing selected representations of said first body and of said second body, the representations for one of said bodies being an implicit representation and the representation for the other body being a discrete representation;

a user controlled hepatic interface device; and

processing apparatus responsive to said interface device for providing simulated movement of the first body relative to the second body, said processing apparatus detecting collisions between the bodies resulting from such simulated movement, including the position on each body of each collision, the direction of the collision, and force for the collision, converting the detected direction, point and force for each collision into at least one force vector and, feeding back the at least one force vector through said interface device.

[28. A system as claimed in claim 26 wherein at least one of said representations is stored as an implicit equation representation of the body.]

29. A system as claimed in claim [28] 26 wherein said first body representation is stored as a binary space partition tree representation.

30. A system as claimed in claim [28] 26 wherein force for a collision is represented at least in part by penetration of the body represented by the implicit [equation] representation into the other body.

[34. A system for controlling the simulated interfacing of a first body controller by a user with a second body, while providing haptic feedback to the user on such interface including:

a memory storing a point cloud representation of at least one of said bodies; and

processing apparatus which utilizes said point cloud representation in said stimulation.]